Nutrient Assessment Protocol for Lakes and Reservoirs in New Mexico

Seva Joseph

Monitoring and Assessment Section of the
Surface Water Quality Bureau
New Mexico Environment Department

How to determine if lakes and reservoirs are impaired by nutrient enrichment based on New Mexico's narrative standard?

"Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in a dominance of nuisance species in surface waters of the state."

This narrative criterion is challenging to assess because:

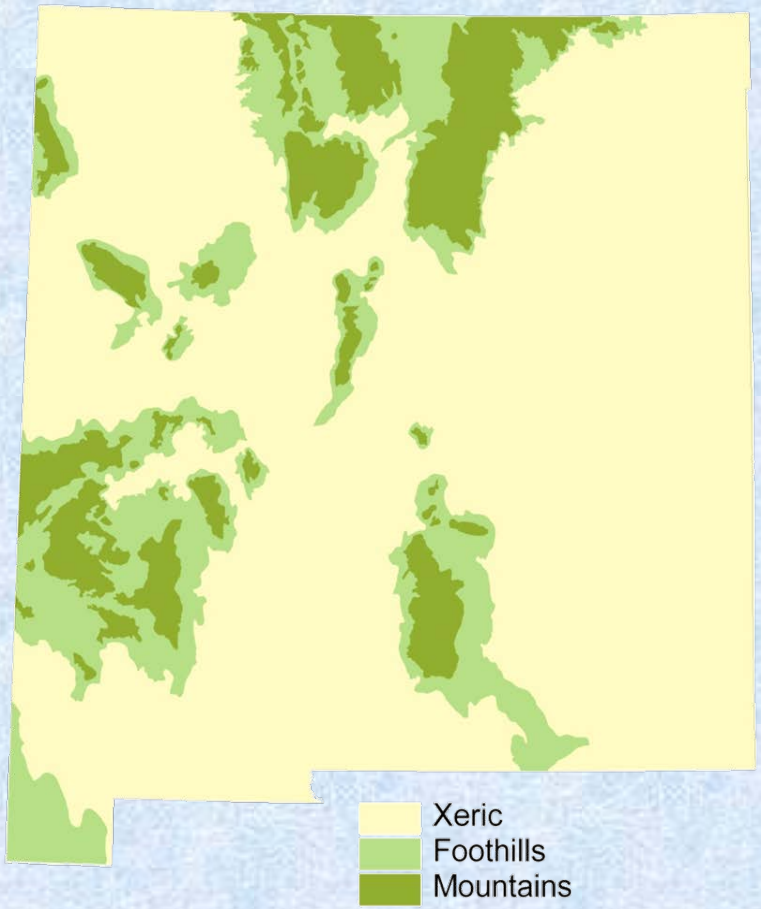
- **distinguishing nutrients from "other than natural causes" is difficult.**
- **the concentration of nutrient that produce "undesirable aquatic life" and results in the impairment of designated uses are not defined**

Impairment thresholds were needed to translate the narrative criterion into quantifiable endpoints.

Available NM Lakes Dataset

- Water quality data from 1989 through 2010 for :
  - Total Phosphorus
  - Total Kjeldahl Nitrogen
  - Nitrate Plus Nitrite
  - Secchi depth
  - Chlorophyll *a* concentration
  - Phytoplankton Community Comp
  - Dissolved Oxygen – depth profile
- 406 sample events from 107 sites on 78 lakes and reservoirs
- Data from 2000-2010 was compiled from the SWQB Database
- Data from 1980-1999 was downloaded from Archival STORET and hard copies of old lake surveys

Partition the datasets



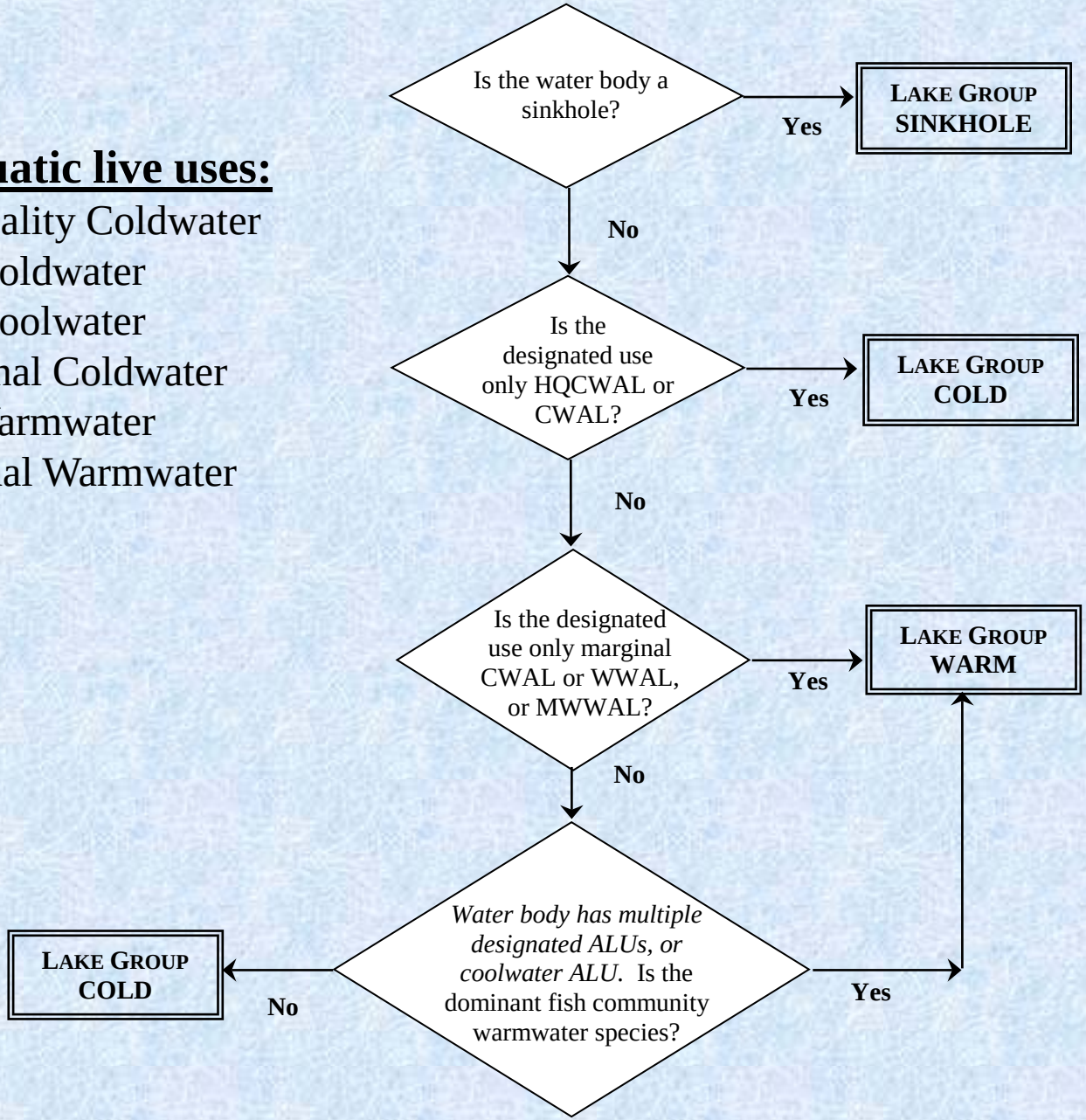
- **Limited aquatic resources in NM**
  - **78 lakes and reservoirs in 121,600 square miles**
- **High ecological variability**
  - **alpine to desert**
- **Natural lakes vs reservoirs**

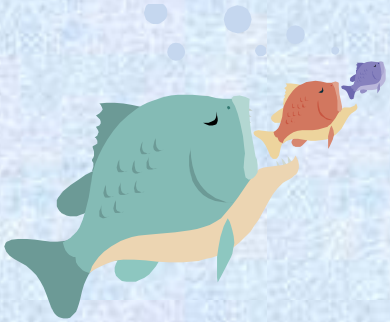
Lake Classification System

- **Separate out sinkholes**
- **Divide the rest by ALU**
  - **Warmwater**
  - **Coldwater**

NM aquatic live uses:

High Quality Coldwater
Coldwater
Coolwater
Marginal Coldwater
Warmwater
Marginal Warmwater





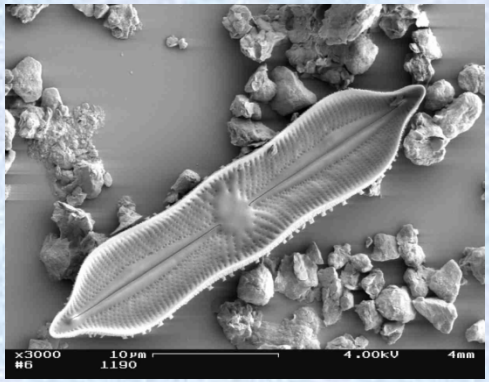
What, when, and where?

What indicators? TN, TP, Secchi, chlorophyll, phytoplankton and DO
DO profile indicators: average of the top 3m, average bottom 3 m, the proportion of the profile below the standard, pass or fail assessment protocol

The proportion (%) of the phytoplankton community made up of **Cyanophytes**

When to collect data? Limited data to those collected during the **growing season** (defined as time between first and last average frost) - did not produce different thresholds, so used all available data.

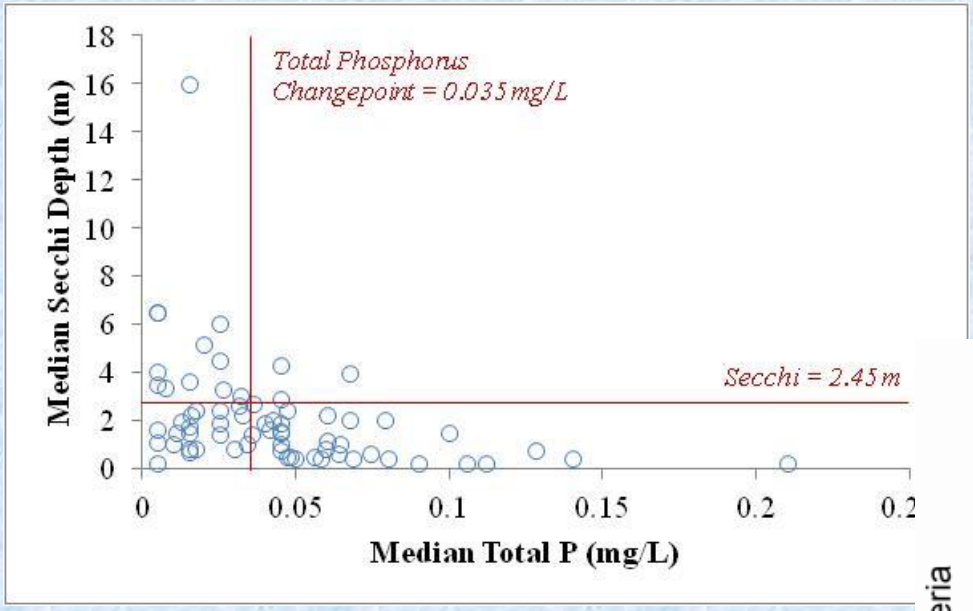
Where should data be collected from? Limited the assessment to data collected at the **deep station** - as the shallow stations were more strongly influenced by wave action and materials suspended in reservoir inflows

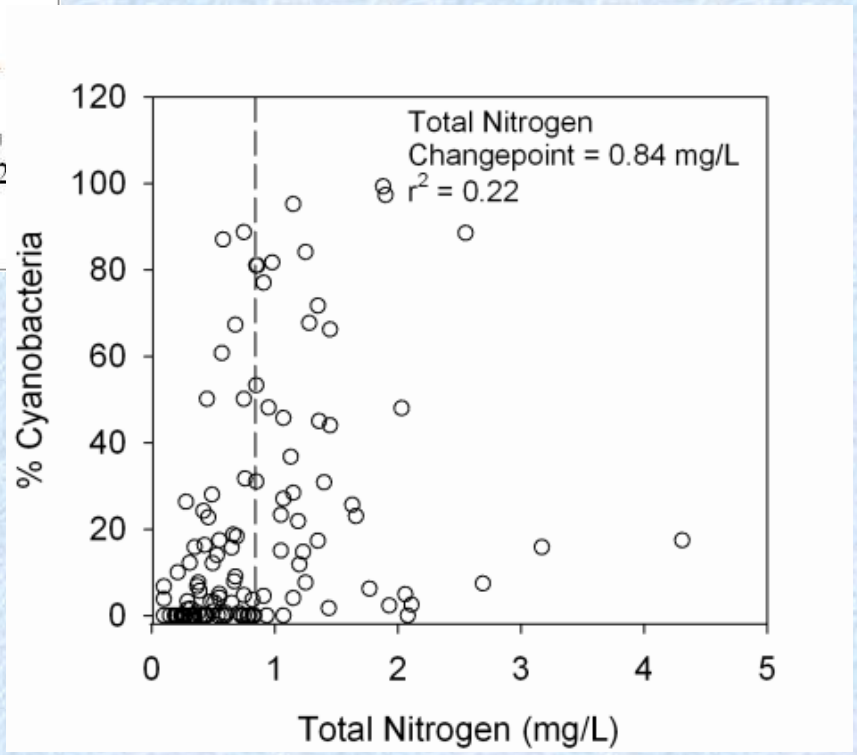


Data Analysis

- Percentiles of nutrient indicators were calculated for the different classes of lakes and reservoirs
- Changepoint and Regression Tree Analyses were used to identify environmental thresholds that result in an ecological change (Analytical Support for Identifying Water Quality Thresholds in New Mexico Surface Waters, J. Thad Scott and Brian E. Haggard)
- Review of literature threshold values

Change point Analyses





Candidate impairment thresholds

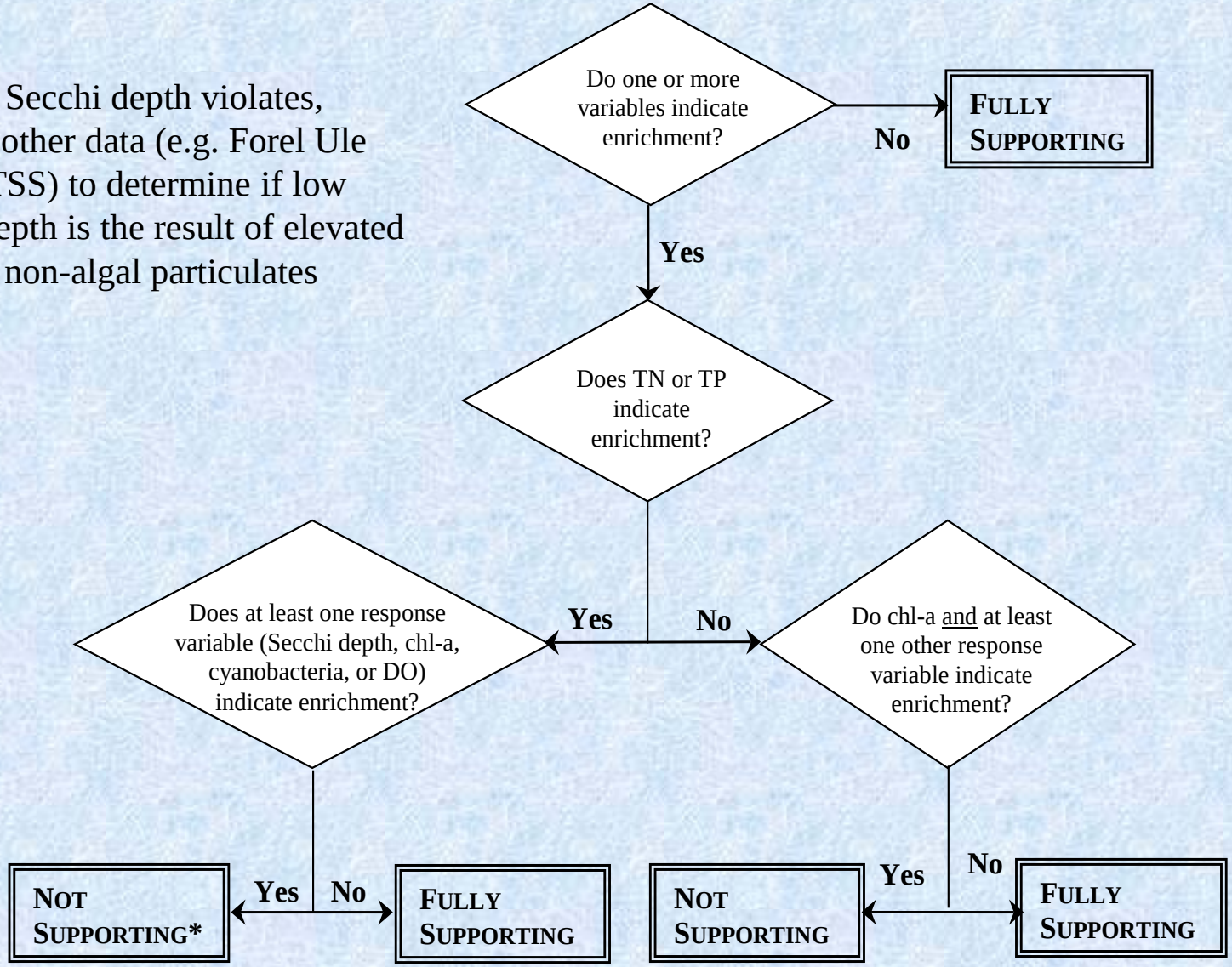
Designated Use/Lake class	Chl-a (µg/L)	Secchi Depth (m)	TP (mg/L)	TN (mg/L)	% Cyano-bacteria	Organization/ Author	Method of threshold derivation
Coldwater candidate thresholds							
NM Coldwater ALU	2.3	1.5	0.03	0.5	-	NMED SWQB	**Median of lake group**
NM Coldwater ALU	6	3	0.05	0.82	21%	NMED SWQB	**75th percentile of lake group**
NM Coldwater ALU	-	2.45	0.04	0.9	38%	U. of Arkansas	**Changepoint analysis**
ID Mountain	1.8	-	0.015	0.28		ID DEQ	**75th percentile of reference**
AZ Coldwater	5-15	1.5-2.0	0.70	1.2	>50%	Arizona DEQ	**AZ trophic index**
mesotrophic-eutrophic boundary	7.5	2	0.030	0.65	-	Nürnberg (1996)	**Literature review**
Warmwater candidate thresholds							
Warmwater ALU	3.2	1	0.04	0.6	-	NMED SWQB	**Median of lake group**
Warmwater ALU	10	1.8	0.07	0.84	31%	NMED SWQB	**75th percentile of lake group**
Warmwater ALU	-	-	0.04	1.41	38%	U. of Arkansas	**Changepoint analysis**
ID Xeric	7.79	-	0.048	0.514	-	ID DEQ	**75th percentile of reference**
AZ Warmwater	25-40	0.8-1.0	0.13	1.7	>50%	Arizona DEQ	**AZ trophic index**
KS Central Plains & SW Tablelands	11	1.2	0.044	0.70	-	KSU & KS Dept Health Env.	**Median of best 1/3**
Sinkhole candidate thresholds							
Sinkhole lakes	-	6	0.025	1.42	-	NMED SWQB	**75th percentile of sinkhole lakes**
oligotrophic-mesotrophic boundary	**3.5**	**4**	**0.01**	**0.35**	-	**Nürnberg (1996)**	**Literature review**

Nutrient-related impairment threshold values for New Mexico's lakes and reservoirs

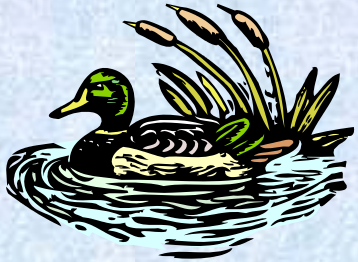
CAUSAL VARIABLES			RESPONSE VARIABLES			
Lake Group	**TP (mg/L)**	**TN (mg/L)**	**Secchi depth (m)**	**Chl-a (µg/L)**	**% Cyano-bacteria**	**DO concentration (mg/L)**
COLD	≤ 0.03	≤ 0.9	≥ 2.0	≤ 7.5	≤ 38%	*See NMAC for applicable DO criterion*
WARM	≤ 0.04	≤ 1.4	≥ 1.2	≤ 11	≤ 38%	
SINKHOLE	≤ 0.025	≤ 1.42	≥ 4.0	≤ 3.5	-	

Generalized flowchart for determining nutrient impairment using multiple lines of evidence

***** If only Secchi depth violates, evaluate other data (e.g. Forel Ule color orTSS) to determine if low Secchi depth is the result of elevated levels of non-algal particulates



Lake TMDLs ?



- New Mexico completed the TMDL Consent Decree in 2007. It did not include any lakes.
- New Mexico currently addresses impairments as part of a watershed TMDL documents. To date, no lake TMDLs have been developed.
- SWQB plans to write lake TMDLs within the watershed TMDL document framework which will address both stream and lake impairments.
- TMDL staff and lake monitoring staff have began coordinating on the collection of data for TMDL development including collection of data at lake inlets and outlets (which had not been don in the past .
- As has been done with some stream TMDLs, the assessment threshold **values may be used as numeric targets** for the parameters of concern.

Questions?

seva.joseph@state.nm.us

http://www.nmenv.state.nm.us/swqb/Nutrients/

Station	ALU	Sampling Date	Dissolved Oxygen (mg/L)	Chlorophyll a (µg/L)	Total Phosphorus (mg/L)	Total Nitrogen (mg/L)	Secchi Depth (m)	D.O. Assess-ment	% Cyano-phyte	# TP	# TN	% Chloro	D.O. Assessment	% Cyano > 38%
Abiquiu Reservoir	CW	4/24/2012	9.35	2.10	0.011	0.3	4	FS	0	1		0	FS	0
		7/31/2012	7.52	5.20	0.05	0.6	5	FS	3					
		8/28/2012	6.72	6.30	0.005	0.38	2.7	FS	0					
		10/2/2012	6.69	1.60	0.015	0.3	2.5	FS	1					
Lake Roberts	CW	3/29/2011	7.43	14.52	0.05	0.3	0.8	0	FS	2	0	100	FS	50
		6/21/2011	8.93	9.35	0.03	0.3	1.3	27	FS					
		8/15/2011	6.77	12.04	0.14	0.71	0.9	43	FS					
		10/18/2011	8.5	rejected	0.02	0.3	0.8	39	FS					
Snow Lake	CW	3/30/2011	8.36	8.12	0.1	0.3	0.3	0	FS	4	3	100	NS	25
		6/22/2011	8.34	18.51	0.08	1.09	0.3	35	NS					
		8/16/2011	6.75	11.84	0.13	1.02	0.4	67	FS					
		10/19/2011	4.72	rejected	0.13	1.34	0.4	7	NS					
Applicable thresholds			6	7.5	0.03	0.9	2	38						

Station	one or more exceed	TN or TP exceed	at least one response	Final Nutrient Assess
Abiquiu Reservoir	NO	NO		Full Support
Lake Roberts	YES	YES	YES	Non Support
Snow Lake	YES	YES	YES	Non Support